

right. He was led into what I think was another error by the disposition of the letters in the MS. As the Madrid edition gives a photo-lithograph of the two pages of the original text containing the alphabet and its explanation, we are in a position to examine it satisfactorily. The figures are arranged in three parallel lines across the page, and the two figures for *u*, stand, the first at the end of one line, the second at the beginning of the next. From their evident connection with the sign for the sky at night, I am of opinion that they belong together as members of the same sign. Or did either member of the pictographic composite serve as indicating its phonetic value?

The designs of buildings as given by Brasseur, pp. 328, 332, 342, are much neater and more regular than in the original, where they are simply out-lined with a pen neither steady nor skillful. The disposition of the parts is, however, the same in both.

From these remarks it will be seen that Don Juan de Dios de la Rada y Delgado has laid students of Maya culture under positive obligations by this new and complete edition of Landa's most important work, and it should find a place in those public and private libraries which aim to have at all a complete list of consulting Americana.

THE FACIAL NERVE IN THE DOMESTIC CAT.

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Introduction.

The embarrassment of the student of comparative anatomy will be greatly relieved, and his progress will be proportionately facilitated, if he has access to a complete description of the structural characters of a typical form. The anatomy of the cat furnishes a desirable and practical standard for comparison—at least for the Mammalia. Special reasons for accepting and adopting this standard have been presented elsewhere. (*Anatomical Technology*, 34, p. 55.)

The osteology and the myology have already been described (34, B.C.). The neurology has been given only in part; the anatomy of the brain has been published by Wilder in the *Anatomical Technology* (34), and in numerous papers by the same author before scientific bodies. (For the bibliography see *Anatomical Technology*.)

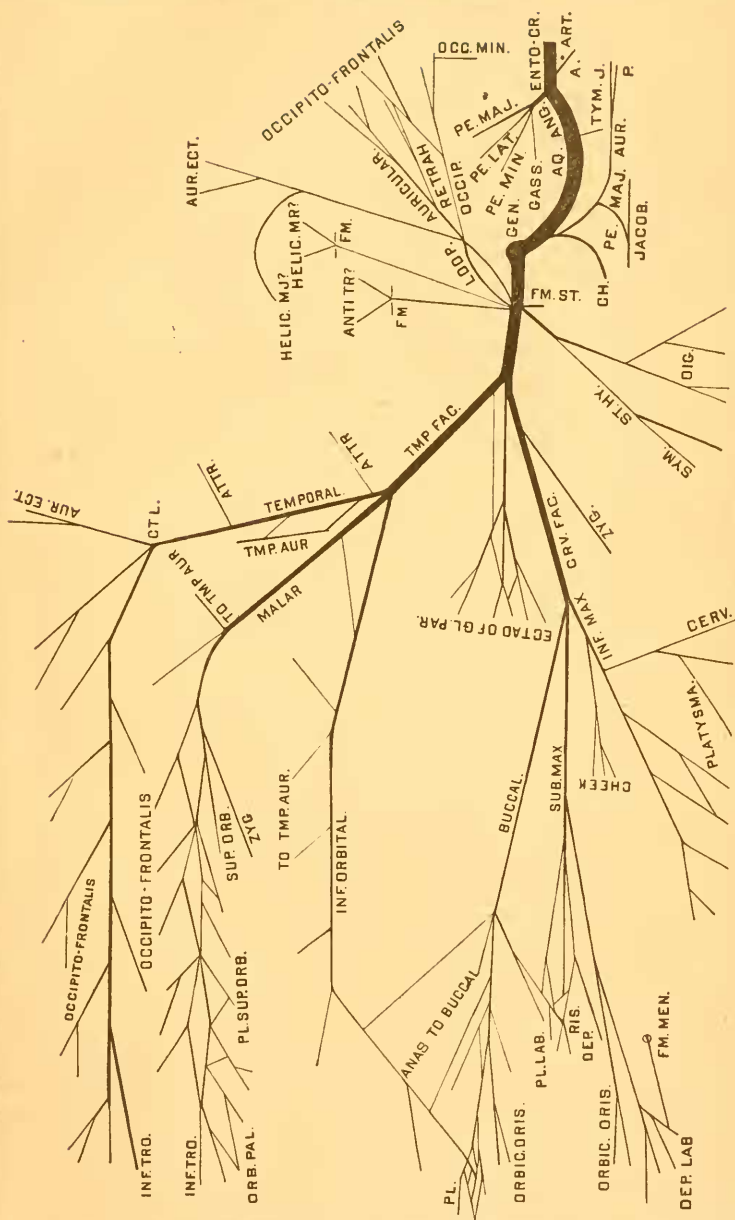


Diagram of the Facial Nerve.—Stowell.

It has seemed desirable that the nerves of the cat be described with the same fullness of detail that has been given to the bones and the muscles.*

The Vagus (27) and the Trigeminus (A.) nerves have been described; the present study of the Facial nerve is now offered as a contribution to comparative neurology. It has been the author's aim to present the relations and the distribution of this nerve, based upon repeated dissections, so as to insure, as far as practicable, the elimination of individual variation.

Preparation.

The cats were injected with the "starch injection mass" recommended in the Anatomical Technology (34, p. 140); both arteries and veins were injected, to facilitate identification and to insure accuracy. Alcoholic and recent specimens were used. Most of the work has been done under a magnifying power of 15-25 diameters, with the hope that no anastomotic or terminal filaments should escape notice.

NERVUS FACIALIS.

Synonymy.—Portio dura (of the seventh pair), Par septimum seu faciale, Communicans faciei nervus, Sympatheticus minor, Ramus durior septimæ conjugationis, Respiratory nerve of the face, Nervus facialis, Facial nerve.

Anatomical Characters.—This nerve is distributed to the muscles which give expression to the face, viz., the muscles of the palpebral, the nasal, the maxillary, the mandibular and the inter-maxillary regions; to two of the principal muscles of the ectal ear, viz., attrahens aurem and retrahens aurem, and to the small muscles of the cartilage (pinna); it gives filaments to the middle ear, directly to the stapedius muscle, indirectly to the tensor tympani and those structures innervated by the tympanic plexus (Jacobson's nerve); it supplies the scalp (occipito-frontal muscle) and the ectal muscle of the cheek and neck (platysma myoides); it communicates with the several divisions of the trigeminus nerve upon the face, and with ganglia of the trunk, viz., with the Gasserian ganglion by a small fascicle, with the sphenopalatine through the great petrosal root of the Vidian

* For the study of individual structure the elaborate and expensive work of Straus-Durekhelm (B.), and the more accessible reduced copies of his outline plates by Professor Henry S. Williams (C.), possess excellent features. The Anatomical Technology by Wilder and Gage (34) is all that can be desired in a manual which is designed "to furnish those who intend to pursue human, veterinary or comparative anatomy, with explicit directions for dissection and for the preparation and preservation of anatomical specimens, and with a correct and clear account of the principal parts of an accessible and fairly representative mammal of convenient size" (Preface, 2d ed.). Directions for dissection and manipulation are so explicit in this manual that it seems unnecessary to describe the methods followed in the preparation of this paper. No work known to the writer, except perhaps Mivart's (18), assumes to present in detail the nervous system of the cat; the wide discrepancy between his text and the nervous system of American cats has been mentioned elsewhere (A; The Nation, June 2, 1881; Science and the Athenæum, June 4, 1881).

nerve, with the otic through the small petrosal, and with the submaxillary through the chorda tympani; it is joined by a considerable fascicle from the auditory nerve near the ectal origin (this is the origin of the chorda tympani, according to Sapolini), by a branch from the glosso-pharyngeal and the vagus nerves; it anastomoses with the superficial cervical and the minor occipital nerves. It is not given to the temporal muscles, although its terminal filaments form dense plexuses upon their ectal surfaces.

Physiological Characters.—This nerve controls facial expression, the movements of the ectal ear and the auditory ossicles; it has a direct action upon the salivary glands. (Sapolini ascribes speech to the chorda tympani, and thinks that the further action of the facial nerve upon the tongue is to govern its movements in deglutition). I do not know that its action upon the auditory nerve has been demonstrated. Its anatomical relations suggest a modifying influence upon the trigeminus, the glosso-pharyngeal and the vagus nerves.

SPECIAL DESCRIPTION.

Proximate Roots.—The union of the proximate roots of the facial nerve may be traced along the ventrimesal border of the sensory root of the trigeminus nerve caudad of the pons.

The dorsal root bends around the caudal root of the trigeminus, crosses its lateral and dorsal faces, and enters the cerebellum with the medipenduncle.

The cephalic root is ventrad of the caudal root of the trigeminus and caudad of the medipenduncle; a portion is reflected dorsad to the cerebellum with the prepeduncle; the larger portion dips into the floor of the epicœle, and may be traced cephalad to the region of the post optici.

The caudal root separates from the cephalic as it passes ventrad of the root of the trigeminus; it lies ventrad of the caudal root of the trigeminus, and passes obliquely meso-caudad to the floor of the metacœle.

Ectal Origin and Entocranial Relations.—The facial nerve takes its ectal origin from the latero-cephalic border of the trapezium, meso-cephalad of the auditory nerve (27, Figs. 1, 2; 34, Fig. 116, and Pl. II, Fig. 3). The distribution of the cerebellar artery is such that the ectal origin is surrounded by arterioles; a small twig from the medicerebellar artery (D) and a venule pass between this nerve and the auditory.

The ento-cranial course is laterad with the auditory nerve; it traverses the ental meatus auditorius with that nerve, its position being dorsad.

Just ectad of the arteriole which separates the facial and the auditory nerves a small ramus apparently unites these nerve trunks, or rather is an accession to the facial nerve. Is this the intermediary nerve of Wrisberg (*portio inter duram et mollem*)? Sapolini maintains that in man this is the origin of the chorda tympani, which he names the thirteenth cranial nerve. He traced this nerve to the geniculate ganglion, and found that the nerve of Wrisberg and the chorda tympani were one and the same nerve. (From a résumé of Sapolini's monograph by Dr. Burnett, pub-

lished in the Medical Times, February 24, 1883, and reprinted in the Medical Record, March 31, 1883, p. 362.)

Intercranial Relations.—The facial nerve traverses the serpentine flexions of the aqueductus Fallopii to the foramen stylo-mastoideum. The course in the aqueduct is first laterad for 2-3 mm.; an abrupt change in direction at this point forms an angle which is directly mesad of the fossa occupied by the spherical tensor tympani muscle; peripherad of the angle the course arches first dorsad (the concavity being ventro-laterad), then laterad (the concavity being ventrad) for 5-7 mm., and lies caudad of the tensor tympani muscle.

About 10 mm. peripherad of the ental meatus auditorius there is a considerable expansion in the aqueduct, about 2 mm. in length; in this fossa a reddish swelling rests upon the facial nerve. This is the ganglion geniculatum, or intumescentia gangliformis.*

From this point the course is laterad to the stylo-mastoid foramen.

At the angle (Fig. Ang.) a considerable twig 2 mm. in length is given off, which traverses a foramen to the ental surface of the cranium, where it divides into four ramuli, which become respectively the mesal root of the great superficial petrosal nerve, the small superficial petrosal, a ramulus to the sympathetic plexus in the carotid rete arteriale, and a fascicle to the eminence on the caudo-lateral angle of the Gasserian ganglia. At a point caudad of the stapedius muscle a fascicle, the tympanic nerve, is sent to that muscle. (It is not clear but that this fascicle has its origin in the geniculate ganglion instead of the nerve trunk.)

Caudad of the geniculate ganglion the fallopian aqueduct arches latero-caudad (the concavity being mesad). In this canal, immediately caudad of the ganglion, are two fasciculi separated by a slender arteriole. These are the chorda tympani and the united anastomotic branch to the glosso-pharyngeal and the vagus nerves with the long root of the petrosal nerve, q. v. The geniculate ganglion embraces these united nerves and the trunk of the facial.

About 5-8 mm. peripherad of the ganglion, where the arch reaches its ventral angle and begins to curve cephalad (the concavity being dorsad), the anastomotic branch bends ventri-mesad, and 5 mm. peripherad it bifurcates to join the petrosal ganglion of the glosso-pharyngeal nerve and the jugular ganglion of the vagus. This is a portion of the auricular branch of the vagus. This point of separation is also the origin of the long root of the great petrosal, q. v.

Chorda Tympani.—This nerve, or the nervus tympano-lingualis, has its origin and course as given above; it continues cephalad in the canal, accompanied by a slender arteriole; it bends dorsad to enter the tympanum through the *iter chordæ posterius*; it crosses the tympanum about

*The author has not at this date completed experiments to satisfy himself as to the relation of this body; whether the relation is one of position only or one of structure—that is, whether it is a ganglion of the facial nerve, or is peculiar to the great superficial petrosal nerve and merely rests upon the facial.

the middle of the malleus, somewhat mesad of the bone, and emerges through a minute foramen, the iter chordæ arterius, into the glaserian canal, thence along the canal to the ecto-cranial foramen; it lies ventrad of the otic ganglion and the dental branch of the mandibular nerve, ectad of the external carotid artery, passes between the pterygoid muscles, and joins the lingual nerve at an acute angle about 5-10 mm. peripherad of the foramen ovale.

Nervus petrosus superficialis major.—The great petrosal nerve has a fourfold origin. The principal root may be traced to the geniculate ganglion with the trunk which is directed caudad from that body; * the next in size comes direct from the petrosal ganglion of the glosso-pharyngeal nerve, and is a division of Jacobson's nerve; the third is a branch from the trunk of the facial, at the angle; and the fourth is a slender filament from the tympanic plexus (Jacobson's). The united trunk lies in the glaserian canal, and emerges from its ventral hiatus, enters the caudal foramen of the Vidian canal, which is about 5 mm. cephalad, traverses the canal, and at the middle of the foramen lacerum anterius becomes the petrosal root of the Vidian nerve, whence it is related to the spheno-palatine ganglion.

Nervus petrosus superficialis minor.—This branch from the interosseous portion of the facial nerve is one of the four divisions of the ramulus given off at the angle; about 2 mm. peripherad of its origin it enters an enlargement (plexus?) about .5 mm. in diameter; this enlargement is joined by the tensor tympani nerve; the petrosal nerve traverses the glaserian canal and joins the otic ganglion at the ventral hiatus.

Ecto-cranial Relations.—The ecto-cranial trunk emerges from the foramen stylo-mastoideum; its course is cephalad and dorsad, and lies ectad of the post-auricular artery. (It often lies entad of a branch artery to the parotid gland.) At the foramen of exit, or just peripherad, the nerve divides into branches; its relations and distribution are given accordingly. The primary rami ventrad are the digastric and the stylo-hyoid; cephalad are the cervico-facial and the temporo-facial; dorsad and caudad are the auricular.

N. digastricus.—The digastric nerve is a small ramus from the ventral border of the facial nerve at its foramen of exit; it lies entad of the stylo-mastoid artery, around the cephalic border of which it bends abruptly and takes its course ventrad; it extends along the dorsal border of the proximal end of the digastric muscle, which it penetrates about 5-8 mm. from its origin; its terminal filaments supply the proximal end of the muscle. (I do not find an anastomotic branch to the glosso-pharyngeal nerves, as is the case in man.)

N. stylo-hyoideus arises from the ventral border of the facial nerve, in common with the digastric, or remains in the trunk-sheath to be given off about 1-2 mm. peripherad; it penetrates the stylo-hyoid muscle at its

* This trunk becomes the anastomotic branch to the glosso-pharyngeal and the vagus nerves, the chorda tympani and the long root of the petrosal nerve.

proximal third, and is distributed throughout the muscle; it often communicates with the cervico-facial nerve about 10 mm. peripherad of its origin. As it crosses the post-auricular artery it gives two or three filaments to the sympathetic plexus around this blood-vessel.

Cephalic Division of the Nerve-Trunk.—As the common trunk emerges cephalad from the foramen of exit, it lies dorsad of the stylo-mastoid artery (a small twig from the post-auricular), and crosses the lateral border of the post-auricular artery; at the dorsal border of the artery the trunk divides into the cervico-facial and the temporo-facial rami. (In some instances this trunk seems to give origin to the stylo-hyoid nerve.)

N. cervico-facialis.—This is the cephalic and ventral ramus of the common trunk; it is ectad of the carotid artery and the facial vein, entad of the submaxillary gland, and upon the ectal surface of the masseter muscle. At the cephalic border of the submaxillary gland it divides into three rami, the infra-maxillary, supra-maxillary and the buccal.

The first branch of the cervico-facial trunk is given off at the origin of this nerve; it lies ectad of the carotid artery, and is directed dorsad and laterad upon the ectal surface of the parotid gland; about 12 mm. from its origin, ectad of Stenon's duct, it bifurcates, each division again branching into two or four ramuli and terminating in the dermal muscle ectad of the gland (*Platysma myoides*). A few filaments may be traced to the zygomatic muscles.

This branch receives a considerable accession from the temporo-facial nerve near its origin; some of the filaments seem to terminate in the substance of the parotid gland.

5-8 mm. peripherad of the origin of the cervico-facial nerve a second fascicle is sent to the zygomatic muscles.

N. infra-maxillaris.—This is the ventral division of the cervico-facial nerve; it lies ectad of the facial artery and the facial vein; 5 mm. peripherad of its origin it divides into several ramuli which anastomose freely and terminate upon the platysma. A large fascicle joins the superficial cervical nerve from the cervical plexus.

N. supra-maxillaris.—This is the middle division of the cervico-facial nerve. (It often arises as a branch of the buccal nerve, given off at the border of the orbicular muscle at the angle of the mouth; its distribution is constant.)

Its general course is toward the angle of the mouth; it lies ectad of the facial artery and vein; it forms a dense plexus upon the ectal surface of the ventral lip; the ventral ramuli supply the muscle between the foramen mentale and the mandibular symphysis (*M. depressor labii*), and anastomose with the mental branch of the mandibular division of the trigeminus nerve; its filaments are also given to the orbicular muscle (*M. orbicularis oris*).

N. buccalis is the dorsal branch of the cervico-facial nerve; it gives several anastomotic filaments to the infra-orbital branch of the temporo-facial nerve; it joins the plexus at the angle of the mouth (*Plexus labii*).

alis); a ramuscle is inflected around the angle of the mouth and anastomoses with the buccal branch of the mandibular division of the trigeminus; it reaches the following muscles: the buccinator, the orbicular, the zygomatic, the risorius and the depressor anguli oris; it continues mesad along the dorsal lip between the superior coronary artery and the vein just dorsad, and at the lateral border of the arteriale rete, just dorsad of the canine tooth, the infra-orbital and the buccal nerves anastomose and form a plexiform swelling for 3-5 mm.; from this united nerve fibres diverge to the levator muscles and to the muscles upon the nasal cartilage.

N. temporo-facialis.—This is the dorsal division of the cephalic trunk as it crosses the post-auricular artery; it is considerably larger than the cervical division (N. cervico-facialis); it lies ectad of the external carotid artery, entad of the ventral lobe of the parotid gland and the adjacent lymphatic gland, and upon the ectal surface of the masseter muscle. Entad of the parotid gland, and 10 mm. peripherad of origin, it divides into three rami—the ventral, or infra-orbital; the middle, or malar; and the dorsal, or temporal (the malar and the temporal often remain in a common sheath for 10-12 mm., forming the temporo-malar trunk).

N. infra-orbitalis.—This, the ventral division of the temporo-facial nerve, emerges from the cephalic border of the parotid gland just dorsad of Stenon's duct; its course is arched toward the angle of the mouth, about midway between Stenon's duct and the zygoma, and lies upon the ectal surface of the masseter muscle; it sustains anastomotic relations with the malar nerve and the temporo-auricular division of the trigeminus nerve. At the ventral border of the zygomatic muscle it gives anastomotic filaments to the cervico-facial nerve, as described; it lies ectad of the zygomatic muscles and dorsad of the superior coronary artery. At the angle of the mouth it gives filaments to the dorsal part of the orbicular muscle; in its course along the dorsal lip it supplies the levator muscles, the muscle at the base of the vibrissæ and the muscles which move the nasal cartilage; it joins the buccal nerve to form the plexiform enlargement in the rete arteriale dorsad of the canine tooth, as already described (v. N. buccalis).

N. malaris.—This is the middle and large division of the temporo-facial nerve; the central portion is covered by the parotid gland; entad of the gland it communicates freely with the temporo-auricular nerve. At the dorsal border of the gland it is apposed to the cephalic temporal artery, and continues along with the artery just caudad of the supra-orbital ridge (the tension of the muscle will dispose the nerve cephalad or caudad of the artery). The principal divisions of the nerve make a dense plexus upon the ectal surface caudad of the supra-orbital ridge; the terminal filaments are given to the occipito-frontal muscle over the frontal region where they anastomose with filaments of the supra-orbital nerve. At the lateral angle of the eye, where a fascicle joins the supra-orbital, a slender nerve is given off to the zygomatic muscles. The nerve trunk may be

traced along the supra-orbital ridge to the mesal angle of the eye, where it joins the infra-trochlear nerve.

N. temporalis.—The temporal branch of the temporo-facial nerve lies close to the basal cartilage of the ectal ear and entad of the parotid gland. The central portion communicates with the temporo-auricular nerve and sends filaments to the attrahens muscle.

At the dorsal border of the gland, and at the ventral border of the long triangular cartilage which is directed meso-cephalad from the dorsal angle of the ectal ear, and which is embedded in the occipito-frontal muscle, the nerve divides; one portion, passing ectad of the cartilage, is distributed to the occipito-frontal muscle in the parietal region; the other, passing entad of the cartilage and along its ventral border, joins the supra-orbital plexus already described.

N. post-auricularis.—This nerve emerges from the stylo-mastoid foramen, and takes its course dorso-caudad in a groove upon the ectal surface of the mastoid process. The central 5 mm. form a loop around the post-auricular artery, one division lying ectad and the other entad of the vessel. These may be described as the auricular and the occipital portions.

The auricular portion, at the peripheral end of the loop, lies apposed to the ectal or caudal division of the artery,* and is distributed to the lateral border of the occipito-frontal muscle. A ramulus from this nerve is given to the retrahens muscle.

The occipital portion lies between the two branches of the post-auricular artery and is distributed to the caudal part of the occipito-frontal muscle; it communicates with a branch of the minor occipital nerve (N. occipitalis minor).

Ramuli to the Ectal Ear.—A ramulus from the auricular nerve is directed toward the tip of the ear; 10 mm. from its origin it gives off 4–5 ramuli, which supply the dermal muscle of the latter half of the ectal ear (probably the platysma); the nerve follows an arteriole around the caudal and the dorsal borders of the ectal ear, and bending around the cephalic margin just distad of the attrahens muscle, it supplies a muscle (helicis major?) upon the ental surface of the ear.

From the ental surface of the facial nerve at the stylo-mastoid foramen a considerable fascicle is directed dorsad close to the proximal cartilage of the ectal ear and entad of the auricular muscles; it penetrates the cartilage and terminates in a muscle (helicis minor?) upon its ental surface mesad of a projection from the ental surface of the ear near the external meatus.

A third ramulus takes its origin at the stylo-mastoid foramen; it is ectad of the post-auricular artery, and crosses the base of the second arteriole, which is sent dorsad from the post-auricular; it follows a small arterial twig about 6–8 mm., when it perforates the auricular cartilage with the

* The artery divides just peripherad of the loop.

arteriole, and terminates upon the thin muscle (anti-tragicus?) at the base of the ear centrad of the folds which extend from the external meatus to the marginal "pocket" of the ectal ear.

SUMMARY.

Anatomical.

PROXIMATE ROOTS.—The dorsal root proceeds from the cerebellum with the medipeduncle.

The cephalic root has one ental origin in the region of the floor of the epicœle or the post-optici part of the mesocœle, and another in the cerebellum, whence it proceeds with the prepeduncle.

The caudal root originates in the caudal portion of the floor of the metacœle.

ECTAL ORIGIN.—This is from the latero-cephalic border of the trapezium; it is separated by an arteriole and a venule from the auditory nerve.

THE EXIT is by the meatus auditorius entalis, dorsad of the auditory nerve, through the aqueductus fallopii, and emerges from the foramen stylo-mastoideum.

PRINCIPAL ECTOCRANIAL DIVISIONS AND THEIR DISTRIBUTION.—*Nervus digastricus* is distributed to the *musculus digastricus*; *N. stylo-hyoideus* to *M. stylo-hyoideus*; *N. cervico-facialis* to the *MM. platysma, orbicularis oris ventralis, depressor labii ventralis, depressor anguli oris, risorius*; *N. temporo-facialis* to the *MM. orbicularis oris dorsalis, buccinator, zygomatici, levatores labii dorsalis, orbicularis palpebræ, occipito-frontalis, attrahens aurem*; *N. auricularis* to the *MM. occipito-frontalis, retrahens aurem, helicis major, helicis minor, antitragicus*.

COMMUNICATING RAMI.

Ento-cranial.—The facial nerve receives an accession just peripherad of the arteriole which separates it from the auditory; this is probably the intermediary nerve of Wrisbery, or the root of the chorda-tympani (Sapolini's thirteenth cranial nerve).

Inter-cranial.—The facial nerve communicates with the spheno-palatine ganglion by the great superficial petrosal root of the vidian nerve; with the otic ganglion by the small superficial petrosal nerve; with the sympathetic plexus by the lateral petrosal nerve; with the Gasserian ganglion of the trigeminus by an anastomotic filament from the ramus at the angle in the aqueduct; with the petrosal ganglion of the glosso-pharyngeal by a large fascicle from the geniculate ganglion; with the jugular ganglion of the vagus by the same fascicle; with the lingual branch of the trigeminus by the chorda tympani; with the stapedius muscle by the tympanic nerve; with the tensor tympani by filaments from the small superficial petrosal nerve.

Ecto-cranial.—The facial nerve communicates with the superficial cervical nerve by the infra-maxillary branch; with the mental nerve (mandibular division of the trigeminus) by the infra-maxillary; with the